SUPPLEMENTATION AND SURVIVAL OF FALL CHINOOK IN SNAKE RIVER 9102900

SHORT DESCRIPTION:
Identify the physical and biological factors influencing survival of Snake River fall chinook salmon. Examine post-release attributes of hatchery fall chinook salmon released into the Snake River to evaluate supplementation strategies. Conduct M & E of supplementation releases from Snake River acclimation facilities.

SPONSOR/CONTRACTOR: BRD
Biological Resources Division (U.S.Geological Survey)
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SUB-CONTRACTORS:
U.S. Fish and Wildlife Service (Idaho Fishery Resource Office) University of Idaho

GOALS

GENERAL:
Adaptive management (research or M&E)

ANADROMOUS FISH:
Research, M&E

NPPC PROGRAM MEASURE:
7.3B.5; 7.5B.3

RELATION TO MEASURE:
This project will evaluate supplementation and gather basic life history data, including identification of the effects of flow and temperature on survival and migration behavior, and quantification of rearing habitat.

BIOLOGICAL OPINION ID:
NMFS BO RPA 13f

TARGET STOCK	LIFE STAGE	MGMT CODE (see below)
Snake River Fall Chinook	Freshwater juveniles and adults	S, (L), W

BACKGROUND

STREAM AREA AFFECTED

Stream name:
Snake River

Subbasin:
Snake River

Stream miles affected:
240

Hydro project mitigated:
N/A. This project does not mitigate for a particular hydro electric project.

HISTORY:
Snake River fall chinook salmon are currently listed as “endangered” under the Endangered Species Act. This study was initiated to identify the physical and biological factors influencing rearing, seaward migration, and survival of fall chinook salmon. This study also examines post-release attributes of hatchery fall chinook salmon released into the Snake River to evaluate supplementation strategies. Monitoring and evaluation of supplementation releases of Lyons Ferry yearlings and subyearlings made at Pittsburg Landing and future Snake River acclimation facilities are included in this work. The monitoring and evaluation will include the monitoring of adult returns to Snake River spawning grounds. Juvenile Snake River fall chinook salmon have evolved to migrate to the ocean as subyearling migrants. We believe that this life history strategy should be studied as one alternative approach for supplementation to increase the number of Snake River fall chinook salmon

The project, which is a cooperative effort between the Biological Resources Division (USGS) and the U.S. Fish and Wildlife Service, started using BPA funding August 1, 1991. Most activities related to the first phase of the project ended in 1996, and the second phase emphasizing supplementation evaluation and survival will start in 1997. The supplementation portion of the study was begun in 1995, and continued through 1996, to obtain preliminary information on the survival of hatchery subyearling fall chinook released in the free-flowing Snake River through lower Snake River dams.

BIOLOGICAL RESULTS ACHIEVED:

This research project has provided much of the contemporary knowledge of Snake River fall chinook salmon. The results of this project have been used in the decision making process to provide summer flows for subyearling chinook salmon in the lower Snake River. Since 1991, this project has produced accurate redd surveys, an estimate of spawning habitat carrying capacity for the Snake River Salmon Recovery Plan, a redd census technique in accord with the recovery plan to measure adult escapement to the spawning grounds, and a model to show the effects of Hells Canyon Complex flows on fall chinook salmon spawning habitat. This information has been used to provide minimum flows during adult spawning and the winter and spring egg incubation and emergence periods in the Hells Canyon Reach. In addition, unprecedented genetic data has been collected on natural Snake River fall chinook salmon confirming the uniqueness of this stock. Documentation of the early life history, physiology, and habitat requirements of fall chinook salmon and models to relate juvenile emigration rate to water temperature and flow have been produced as well. Our laboratory data suggest a link between water velocity and migratory behavior. This project has shown that factors such as fish size and water temperature are important to subyearling chinook emigration rate and survival. Preliminary survival estimates from 1995 show that survival decreased as fish were released later in the season at three sites. Survival ranged from 0.58-0.68 in fish released in the free-flowing Snake River and from 0.38-0.49 for fish released near the head of Lower Granite Reservoir. Preliminary survival estimates from 1996 of fish released at Pittsburg Landing showed a similar trend to 1995 of decreasing survival with later release date. Survival of fish released in early June to Lower Granite Dam was 0.56, whereas fish released in July only survived at 0.054. Emigration rate from the Hells Canyon Reach to Lower Granite Dam is about 2 km/d (range = 0.6 to 9.3 km/d) and it generally takes subyearling migrants anywhere from 4 to 116 days to reach the dam. This project's radio telemetry work has shown that subyearling chinook salmon tagged at Lower Granite Dam migrate fairly rapidly to the forebay of Little Goose Dam and then can spend considerable time there before passing the dam.

PROJECT REPORTS AND PAPERS:

The project has produced four annual reports to BPA and a fifth is in preparation. Quarterly reports have been provided to BPA. The project releases weekly reports to interested parties during the spring emergence and downstream migration of fall chinook salmon and during fall spawning in the Snake River. Peer review journal articles have been prepared or are in preparation.

Papers:

Nelson, W.R., L.K. Freidenburg, and D.W. Rondorf. Accepted. Swimming behavior and performance of emigrating subyearling chinook salmon. Transactions of the American Fisheries Society.

Rondorf, D.W., and W.H. Miller, editors. 1993. Identification of the spawning, rearing, and migratory requirements of fall chinook salmon in the Columbia River basin. 1991 Annual Report to Bonneville Power Administration, Contract DE-AI79-91BP21708, Portland, Oregon.

Rondorf, D.W., and W.H. Miller, editors. 1994. Identification of the spawning, rearing, and migratory requirements of fall chinook salmon in the Columbia River basin. 1992 Annual Report to Bonneville Power Administration, Contract DE-AI79-91BP21708, Portland, Oregon.

Rondorf, D.W., and K.F. Tiffan, editors. 1994. Identification of the spawning, rearing, and migratory requirements of fall chinook salmon in the Columbia River basin. 1993 Annual Report to Bonneville Power Administration, Contract DE-AI79-91BP21708, Portland, Oregon.

Rondorf, D.W., and K.F. Tiffan, editors. 1996. Identification of the spawning, rearing, and migratory requirements of fall chinook salmon in the Columbia River basin. 1994 Annual Report to Bonneville Power Administration, Contract DE-AI79-91BP21708, Portland, Oregon.

Rondorf, D.W., and K.F. Tiffan, editors. In preparation. Identification of the spawning, rearing, and migratory requirements of fall chinook salmon in the Columbia River basin. 1995 Annual Report to Bonneville Power Administration, Contract DE-AI79-91BP21708, Portland, Oregon.

Connor, W.P., H. Burge, and R. Bugert. 1992. Migration timing of natural and hatchery fall chinook salmon in the Snake River Basin. Pages 46-56 in Passage and survival of juvenile chinook salmon migrating from the Snake River Basin. Proceedings of a technical workshop. Prepared by the Idaho Chapter of the American Fisheries Society, Idaho Water Resources Institute, University of Idaho Cooperative Fish and Wildlife Research Unit, and the Western Division of the American Fisheries Society.

Connor, W.P. and several co-authors. In preparation. Stock and race identification of subyearling chinook salmon in the Snake

River. A manuscript to be submitted to the North American Journal of Fisheries Management in 1996.
Connor, W.P. and several co-authors. In preparation. Snake River fall chinook salmon early life history: past and present. A manuscript to be submitted to the North American Journal of Fisheries Management in 1996.
Connor, W.P. and several co-authors. In preparation. Fall chinook salmon spawning habitat availability in the Snake River. A manuscript to be submitted to the North American Journal of Fisheries Management in 1996.
Garcia, A.P. and several co-authors. In preparation. Fall chinook salmon spawning ground surveys in the Snake River. A manuscript to be submitted to the North American Journal of Fisheries Management in 1996.
Tiffan, K.F. and several co-authors. In preparation. Morphological differences between emigrating juvenile spring and fall chinook salmon in the Snake River. A manuscript to be submitted to the Transactions of the American Fisheries Society in 1996.
Tiffan, K.F. and several co-authors. In preparation. Marking subyearling chinook salmon to estimate adult contribution in the Columbia River. A manuscript to be submitted to the North American Journal of Fisheries Management in 1996.

Presentations:
Connor, W.P. 1991. Consequences of spawning habitat selection by summer and fall chinook salmon on restoration efforts in the Clearwater River of Idaho. A presentation to the Western Division of the American Fisheries Society Annual Meeting, Bozeman, Montana.
Connor, W.P. 1992. Migration timing of natural and hatchery fall chinook salmon in the Snake River Basin. A presentation to the Idaho Chapter of the American Fisheries Society Passage and Survival workshop, Moscow, Idaho.
Connor, W.P. 1993. Application of PIT tags to study Snake River fall chinook salmon early life history. A presentation to participants of the Pacific States Marine Fisheries Commission's 1993 PIT-tag workshop, Portland, Oregon.
Connor, W.P. 1994. Estimating fall chinook salmon spawning habitat availability and seeding level in the lower Clearwater River, Idaho. A presentation to the Idaho Chapter of the American Fisheries Society, McCall, Idaho.
Connor, W.P. 1995. Stock and race identification of subyearling chinook salmon in the Snake River. A presentation to the Idaho Chapter of the American Fisheries Society, Boise, Idaho.
Connor, W.P. 1996. Philosophy and PIT tags; do the ends justify the means? A presentation to participants of the Pacific States Marine Fisheries Commission's 1996 PIT-tag workshop, Portland, Oregon.
Connor, W.P. Use of separation by code for fall chinook salmon research in 1995. A presentation to participants of the Pacific States Marine Fisheries Commission's 1996 PIT-tag workshop, Portland, Oregon.
Tiffan, K.F. 1995. Osmoregulatory and ATPase development in subyearling fall chinook salmon. A presentation to the 18th Annual Smolt Workshop, Corvalis, Oregon.
Tiffan, K.F., and D.W. Rondorf. 1996. Osmoregulatory and ATPase development in subyearling fall chinook salmon in the Columbia River. A presentation to the International Congress on the Biology of Fishes. San Francisco, California.

ADAPTIVE MANAGEMENT IMPLICATIONS:
The Northwest Power Planning Council has identified a variety of programs to address the needs of fish and wildlife within the Columbia River basin. This study falls under Program 7.5B.3 "Continue to fund basic life history studies for Snake River fall chinook salmon", which should, "identify the range, limiting factors, effects of flow, temperature, spawning, and rearing habitat, and migratory behavior." However, various aspects of this study also fall under other Programs and have produced information useful in management decisions. We have produced current information on juvenile fall chinook emigration timing and rates in the Snake River, which has been used by fishery managers in making flow decisions under Program 5.4B Summer Migrants, which "provides flow for juvenile fall chinook salmon", and has been relied heavily upon in preparation of recovery planning documents. Our work on spawning, incubation, and rearing requirements for naturally produced Snake River fall chinook salmon has been used to shape flows from Hells Canyon Complex for these life stages under Program 6.1C.2,3 "Provide minimum flows for spawning, incubation, and rearing in Hells Canyon Reach."

The newest phase of this project focuses on monitoring and evaluation of supplementation as a recovery strategy. We started the work as per the Snake River Salmon Recovery Team's final recommendations to the National Marine Fisheries Service, the proposed recovery plan by the NMFS, and NPPC Program measure 7.5B.3. Our new work focuses on natural and hatchery fall chinook salmon juveniles and adult returns to the spawning grounds. A major emphasis will be the comparison of performance and interactions between hatchery and wild fish. Any management decisions regarding the use of supplementation to recover wild Snake River fall chinook salmon must consider the positive and negative impacts that hatchery fish may have on the wild stock. This study will not only produce survival estimates, but will examine the underlying mechanisms behind survival so that decisions can be based on an understanding of the processes behind survival. Relevant information that can be used in decision making processes will include the influence of fish age, size, release site, release timing, and acclimation on yearling and subyearling chinook salmon survival through the lower Snake River. The survival advantage from growth can be framed against risk from predation and can be used to model survival potential under different growth/predation scenarios. Monitoring and

evaluation of adult returns above Lower Granite Dam will also be conducted to maintain redd counts for natural fall chinook spawning and establish a database for hatchery adult returns to the spawning grounds. By evaluating supplementation in light of survival, underlying mechanisms, and adult returns, information will be produced that managers can use to improve survival and therefore increase the number of Snake River fall chinook salmon.

Currently, information from this project has been used in documents such as the Draft Snake River Salmon Recovery Plan Recommendations. In addition, information has been used by the BPA, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the Fish Passage Center, the Fish Operations Executive Committee, Technical Management Team, and numerous others.

PURPOSE AND METHODS

SPECIFIC MEASUREABLE OBJECTIVES:

This study will both directly and indirectly increase the number of fall chinook salmon in the Snake River basin. Dependent upon availability, we will release a total of 48,000 juvenile hatchery fall chinook salmon in the Hells Canyon Reach of the Snake River during each year of the study. This direct increase in the number of juveniles out planted should produce an increase in the number of returning adults. If these adults are allowed to spawn naturally, then an increase in the natural population of fall chinook salmon should be realized. Indirect increases in the number of naturally produced fish will come through knowledge gained from this study which fishery managers can use to optimize survival and therefore increase the number of Snake River fall chinook salmon. The study objectives are as follows:

1) Determine the effects of early life history on natural fall chinook salmon survival to the tail race of Lower Granite Dam.
2) Investigate the occurrence of autumn subyearling and spring yearling emigration in Snake River fall chinook salmon populations.
3) Evaluate post-release attributes and survival of four hatchery rearing treatments of Lyons Ferry fall chinook salmon including acclimated yearlings, non-acclimated yearlings, non-acclimated subyearling parr, and non-acclimated subyearling smolts.
4) Define the effects of post-release attributes and the environmental conditions during rearing and emigration on survival estimates for each hatchery treatment.
5) Use a bioenergetics approach to assess potential growth advantage and predation risk for hatchery treatments and natural fall chinook salmon.
6) Monitor adult returns of natural and hatchery fall chinook salmon to the Snake River spawning grounds.

CRITICAL UNCERTAINTIES:

The success of this project is contingent on the availability of hatchery yearling and subyearling fall chinook salmon to use for supplementation and survival estimation. Because of the endangered status of natural Snake River fall chinook salmon, hatchery fish must be used as surrogate research animals. Use of hatchery subyearlings will allow direct comparison to survival of the wild population, which also emigrate as subyearlings. This research will benefit wild fall chinook salmon in the Snake River and improve supplementation only if it is conducted in accordance with the natural life history cycle.
Supplementation using hatchery fish is assumed to be beneficial. However, negative hatchery/wild interactions are undefined at present. This project will explore a variety of interactions.
This project is also contingent on successful operation of PIT-tag slide diversion gates at Snake River dams to recapture PIT-tagged salmon. This system operated successfully at Lower Granite Dam in 1995 and at Lower Granite and Little Goose dams in 1996.
There are no risks associated with this project. We believe this study will not jeopardize Snake River fall chinook salmon and will pose minimal risk to the public welfare and governmental and tribal interests.

BIOLOGICAL NEED:

Fall chinook salmon are currently endangered in the Snake River. This study was initiated to provide information to aid recovery efforts. Supplementing the natural population with juvenile hatchery fish is one strategy currently proposed to facilitate recovery of this stock. The use of supplementation is one means of increasing the number of fall chinook salmon, but will not necessarily equate with an increase in survival. It is therefore imperative to identify which variables and mechanisms influence survival to incorporate them into tools that fishery managers can use. One of the major weaknesses of past supplementation projects has been the lack of information compiled on the interactions between hatchery and natural fish (Winton and Hilborn 1994). Since hatchery fish are being used to supplement the natural population, it will be necessary to determine if competition for food and

habitat exists, if the health of hatchery fish poses any risk to wild fish, if hatchery and wild fish exhibit differential growth, and if differential predation exists. Presently, hatchery fish are in short supply so determining the optimal size at release, release site, release time, and release pattern will allow for the development of the most appropriate supplementation strategy for fall chinook salmon. This study, will increase our understanding of fall chinook salmon in the Snake River and will result in more effective use of hatchery fish in recovery efforts.

Snake River fall chinook salmon are unique in that they primarily spawn and rear in the mainstem Snake River. This is a significant because the Snake River is a regulated system which can be operated to potentially benefit fall chinook salmon. Both spawning and summer emigration flows are currently provided to increase survival. The need to evaluate survival of both hatchery and wild fall chinook salmon in light of hydropower system operations is critical. This study is necessary to efficiently manage both fish and the hydropower system.

HYPOTHESIS TO BE TESTED:

1) Ho: The rearing history of natural and hatchery fall chinook salmon does not affect survival.
Ha: The rearing history of natural and hatchery fall chinook salmon does affect survival. For example, early emigrants may survive better than late emgirants.
2) Ho: Natural and hatchery fall chinook salmon survival is not dependent on the environmental conditions during rearing and emigration.
Ha: Natural and hatchery fall chinook salmon survival is dependent on the environmental conditions during rearing and emigration. For example, high water temperatures may increase susceptibility to disease and thereby decrease survival.
3) Ho: Growth and predation risk in nearshore rearing areas does not affect natural and hatchery fall chinook salmon survival.
Ha: Growth and predation risk in nearshore rearing areas does affect natural and hatchery fall chinook salmon survival. For example, predation in rearing areas is a direct mechanism of decreased survival.
4) Ho: Juvenile fall chinook salmon survival is not related to adult returns to the spawning grounds.
Ha: Juvenile fall chinook salmon survival is related to adult returns to the spawning grounds. For example, release groups with high survival may return more adults than do groups with low survival.
5) Ho: Supplementation in the Snake River above Lower Granite Dam with Lyons Ferry fall chinook salmon will not affect adult returns to the spawning grounds.
Ha: Supplementation in the Snake River above Lower Granite Dam with Lyons Ferry fall chinook salmon will affect adult returns to the spawning grounds. For example, return of hatchery adults to spawning grounds may be proportional to the number of hatchery juveniles released.

ALTERNATIVE APPROACHES:

N/A. This research must be conducted in the Snake River and by the proposed methods to be applicable to Snake River fall chinook.

JUSTIFICATION FOR PLANNING:

N/A. This project focuses on field research efforts to benefit and recover Snake River fall chinook salmon.

METHODS:

Two size groups of non-acclimated hatchery subyearling fish (75 mm and 95 mm) will be released at Pittsburg Landing in Hells Canyon. These sizes were chosen to represent parr-sized fish and smolt-sized fish. There will be four replicate releases (3,500 each) of these groups each year. One group of hatchery yearlings (10,000) will be released one day prior to release of 30-day acclimated yearlings (10,000). These sample sizes were chosen to be able to recover enough fish at downstream dams to estimate survival and evaluate size at release and acclimation effects. All fish will be PIT tagged before release. We propose to PIT tag sufficient numbers of naturally produced fall chinook salmon in the Snake River to allow survival estimation. Fish will be recaptured in beach seines and at lower Snake River dams and a recapture database compiled. Biological (fish health, physiology, growth, predation), behavioral (travel time, dispersal, nearshore rearing), and environmental (flow, temperature) information will be collected for relation to survival. Survival will be estimated using the Survival Under Proportional Hazards (SURPH) model for recaptured PIT-tagged salmon. Multifactor Analysis of Variance will be used to test for differences in survival and the relation between survival and covariates such as flow and temperature. Multiple regression analysis will be used to identify biological, behavioral, and environmental attributes that affect survival of subyearling fall chinook salmon. The contribution of natural and hatchery fall chinook salmon returning to spawning grounds will be monitored through redd counts, radio tracking, and carcass surveys.

PLANNED ACTIVITIES

SCHEDULE:

PROJECT COMPLETION DATE:
2000

CONSTRAINTS OR FACTORS THAT MAY CAUSE SCHEDULE OR BUDGET CHANGES:
This study depends upon obtaining appropriate ESA and state fish collection permits. Accomplishing study objectives is partially dependent upon obtaining sufficient numbers of Lyons Ferry Hatchery subyearling fall chinook salmon as research animals each year. Permits have been applied for and research fish have been obtained for 1997 research to go forward. Hatchery fish used in subsequent years will be requested on an annual basis.

OUTCOMES, MONITORING AND EVALUATION

SUMMARY OF EXPECTED OUTCOMES

Expected performance of target population or quality change in land area affected:
This study is designed to provide information on the factors that limit survival of both wild and hatchery Snake River fall chinook salmon. Gaining an understanding of the relation between and among fall chinook salmon survival, fish health, post-release behavior, and environmental variability can be used to develop models that predict survival under different supplementation strategies, and biological and environmental scenarios. The interactions between hatchery and wild fish and whether supplementation produces the desired effect of increasing the natural population will be critical information produced by this study. Supplementation releases made under this study will directly increase the number of adult fall chinook salmon returning to the Snake River and promote the recovery of the natural population.

Present utilization and convservation potential of target population or area:
Snake River fall chinook salmon are currently listed as endangered and are protected under the Endangered Species Act. This prohibits any willful take of these fish. However, since Snake River fall chinook are part of a mixed stock fishery as adults, a small number are probably unknowingly taken in commercial, sport, and tribal harvests. Current conservation potential of Snake River has been reduced because of hydropower development. Only the Hells Canyon Reach and the lower portions of tributaries remain as spawning and rearing habitat.

Assumed historic status of utilization and conservation potential:
Historic utilization of Snake River fall chinook salmon is unknown, however, it is estimated that 72,000 adults returned to the Snake River annually from 1938-1949. Historically, fall chinook were able to ascend the Snake River to Shoshone Falls in south central Idaho, and utilized the upper reaches of the Snake River as primary production areas.

Long term expected utilization and conservation potential for target population or habitat:
The long-term conservation goal for Snake River fall chinook salmon is to recover the stock as a naturally reproducing population to a level where ESA protections are unnecessary.

Contribution toward long-term goal:
Results from this study will be used to assist WDFW in management decisions regarding future supplementation, and provide insight to the relation between and among Snake River fall chinook salmon survival, fish health, post-release behavior, and environmental variability. Successful supplementation efforts will contribute to the long-term goal by increasing the natural production.

Indirect biological or environmental changes:
N/A. There will be no indirect biological or environmental changes or impacts resulting from this study.

Physical products:
All hatchery fall chinook salmon and up to 3,000 wild fall chinook salmon may be PIT tagged annually. See also METHODS.

Environmental attributes affected by the project:
Since the Snake River is a regulated system, it is hoped that fishery managers and hydropower operaters can use the information from this study to operate the system to maximize survival of juvenile and adult fall chinook salmon. Two attributes that could potentially be manipulated to benefit salmon are flow and temperature.

Changes assumed or expected for affected environmental attributes:
Any short or long term changes apply to benefits derived rather than to the attributes themselves. If hydropower managers operate the Snake River system to benefit salmon, the short and long term results will be increased fish survival and production.

Measure of attribute changes:
N/A. This study does not reduce sedimentation or produce habitat.

Assessment of effects on project outcomes of critical uncertainty:
If sufficient number of hatchery fish are not made available beyond 1997, then our study design will be modified to include the number of fish that are available. Fish have already been made available for research to go forward in 1997. Any adverse hatchery/wild fish interactions that are described by this project will not be detrimental to the success of the overall project. Fishery managers will have to use such information when making decisions regarding supplementation. Two PIT-tag slide gates for the separation-by-code system are currently operational. If one should fail, the other could be used, and the project outcome should not be affected.

Information products:
This project will produce annual redd counts in the Snake River to monitor adult returns and evaluate the efficacy of supplementation. Supplementation will be evaluated in terms of survival and post-release behavior to provide fishery managers with the most effective release strategy. A model will be produced that will allow prediction of survival under different release scenarios and levels of biological and environmental attributes. Finally, causal mechanisms underlying survival will be sought to identify where mortality occurs and what steps can be taken to increase survival.

Coordination outcomes:
Coordination of this study with the studies listed under "Related BPA Projects" will maintain consistency between methodologies so compatible data can be produced. This will allow direct comparisons of results from the different studies to produce a more comprehensive evaluation of survival and supplementation in the Snake River basin than any one study could provide. At the completion of this study, we will collaborate with our coordinators to produce peer-reviewed journal articles. Finally, coordination will result in the wisest use of Lyons Ferry Hatchery fish, which are in short supply, and will reduce project costs.

MONITORING APPROACH
The region should continue to support spawning redd counts and PIT tagging fish released for supplementation so that survival can be estimated and used to detect problems with releases.

Provisions to monitor population status or habitat quality:
Annual redd counts will be made to monitor adult returns to Snake River spawning grounds. This project has conducted counts since 1991, and has established protocols and methodologies to ensure the highest degree of accuracy possible. PIT tagging wild juvenile fall chinook salmon partially serves as a mean to track the relative strength of the juvenile population each year and will continue through the life of the project.

Data analysis and evaluation:
Survival will be estimated using the Survival Under Proportional Hazards (SURPH) model for recaptured PIT-tagged salmon. Multifactor Analysis of Variance will be used to test for differences in survival and the relation between survival and covariates such as flow and temperature. Multiple regression analysis will be used to identify biological (growth, predation, size), behavioral

(migration timing, travel rates), and environmental (flow, temperature) attributes that affect survival of subyearling fall chinook salmon. The contribution of natural and hatchery fall chinook salmon returning to spawning grounds will be monitored through redd counts, radio tracking, and carcass surveys.

Information feed back to management decisions:
Information transfer has and will take place biannually at Fall Chinook Coordination meetings which involve all interested parties conducting research on fall chinook salmon within the Columbia River basin. In addition, meetings between researchers and fishery managers occur when research activities require additional coordination. Information will also be produced in technical annual reports and peer-reveiwed journal articles.

Critical uncertainties affecting project's outcomes:
Fishery managers should give a higher priority to research using subyearling fall chinook salmon rather than obtaining hatchery production goals. The reason for this is that returning adults from juveniles supplementation releases will produce progeny with a subyearling life history cycle. If research fish are consistently made available, then questions pertaining to survival will not have to be revisited in the future. The time is now to learn about subyearlings, not later.

EVALUATION
This project will produce the following deliverable products which might be used to assess overall performance. 1) Summary of which combinations of release size, release timing, release site, hatchery rearing history, acclimation, and environmental variables produce the highest survival and adult returns to spawning grounds. 2) Development of a model to predict survival under a range of flows, temperatures, supplementation strategies, rearing conditions, and physiological development. 3) Determination of the amount of rearing habitat where growth is maximized and the extent of competition between hatchery and wild fish in those habitats. 4) Determination of the predation risk and growth advantage to juvenile fall chinook salmon as related to survival under different supplementation scenarios and environmental conditions. 5) Identification of the biological and environmental factors that contribute to residualism and its consequences to the stock.

Incorporating new information regarding uncertainties:
Any new information will be used to adapt the project to ensure that it will accomplish its objectives.

Increasing public awareness of F&W activities:
N/A.

RELATIONSHIPS

RELATED BPA PROJECT	RELATIONSHIP
9403400 Assessing summer/fall chinook restoration in the Snake River basin. Nez Perce Tribe	This project examines spawning, incubation, growth, emigration, and survival of summer/fall chinook salmon in the Clearwater River and compliments our project in the Snake River.
9302900 Survival estimates for the passage of juvenile salmonids through dams and reservoirs of the lower Snake and Columbia rivers. National Marine Fisheries Service	This project will provide estimates of reach and project survival probabilities of juvenile salmonids through Snake River dams. Efforts focus on survival through reservoirs and dams, whereas our project focuses on survival in nearshore rearing habitats and through the free-flowing reach of the Snake River.

OPPORTUNITIES FOR COOPERATION:
This project is a cooperative effort between the Biological Resources Division (USGS), U.S.Fish and Wildlife Service, National Marine Fisheries Service, Washington Department of Fisheries and Wildlife, and Nez Perce Tribe of Idaho. Cooperation was sought to produce a coordinated effort with other agencies to produce the necessary information while keeping costs down and eliminating duplicative activities.

COSTS AND FTE

1997 Planned: $1,000,000

FUTURE FUNDING NEEDS:

FY	$ NEED	% PLAN	% IMPLEMENT	% O AND M
1998	$900,000		100%	
1999	$900,000		100%	
2000	$900,000		100%	
2001	$0			
2002	$0			

PAST OBLIGATIONS (incl. 1997 if done):

FY	OBLIGATED
1991	$812,359
1992	$934,211
1993	$915,452
1994	$1,053,426
1995	$1,124,761
1996	$989,947
TOTAL:	$5,830,156

Note: Data are past obligations, or amounts committed by year, not amounts billed. Does not include data for related projects.

OTHER NON-FINANCIAL SUPPORTERS:
N/A.

LONGER TERM COSTS: N/A

1997 OVERHEAD PERCENT: 38%

HOW DOES PERCENTAGE APPLY TO DIRECT COSTS:
Total direct costs

CONTRACTOR FTE: 9

SUBCONTRACTOR FTE: 6